Learning and Individual Differences xxx (2012) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Learning and Individual Differences

journal homepage: www.elsevier.com/locate/lindif

Interest, inferences, and learning from texts

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ARTICLE INFO

Article history:
Received 19 September 2011
Received in revised form 26 April 2012
Accepted 6 July 2012
Available online xxxx

Keywords:
Topic interest
Inference generation
Learning from texts
Think aloud
Text coherence

ABSTRACT

Topic interest and learning from texts have been found to be positively associated with each other. However, the reason for this positive association is not well understood. The purpose of this study is to examine a cognitive process, inference generation, that could explain the positive association between interest and learning from texts. In Study 1, sixty undergraduate students participated by reading two science texts, which differed in coherence levels, silently. The results replicated previous findings that topic interest is positively associated with recall and accurate answers to comprehension questions for both texts. In Study 2, sixty-nine undergraduate students participated by reading the same two science texts while thinking aloud. The results indicated that topic interest was positively associated with inference generation while reading for the more coherently-written text. Subsequent analyses indicated inference generation partly explained the positive association between topic interest and accurate answers to comprehension questions for the more coherently-written text. The findings from Study 2 were independent of the effects of reading comprehension skill. Theoretical implications of the findings, in regard to standards of coherence and depth of processing while reading, are discussed.

1. Introduction

It has been well noted in the literature that topic interest is positively associated with learning from texts (Ainley, 2006; Dewey, 1913; Hidi, 1990, 2001, 2006; Krapp, 1999; Renninger, 2000; Schiefele, 1991). Previous research findings have shown that topic interest is positively associated with performance on cloze assessments of texts (Asher & Markell, 1974), accurate answers to open-ended reading comprehension questions (Schiefele, 1990), text recall (Naceur & Schiefele, 2005; Schiefele & Krapp, 1996), and accurately completing diagrams about information in the text (Boscolo & Mason, 2003). However, the cognitive process responsible for this positive association is uncertain. The purpose of this study is to examine a potential explanation of the positive association between topic interest and learning from texts.

There has been an intriguing discussion in the literature regarding whether topic interest is an aspect of *individual interest* or *situational interest*. Individual interest is a person's enduring opinion on a particular domain (e.g., a stable, positive orientation toward learning about dinosaurs; Hidi, 1990; Schiefele, 1999). Individual interest stems from within an individual and develops over a significant length of time (Krapp, Hidi, & Renninger, 1992). In contrast, situational interest is a temporary state, induced by certain features of the environment, such as unexpectedness (Hidi & Renninger, 2006; Schiefele, 1999). One manner of conceptualizing the differences between individual and situational interest is to consider individual interest as the "interestedness" of the person and situational interest as the "interestingness" of the situation (Bray & Barron, 2004; Frick, 1992; Hidi & Baird, 1986).

One view of topic interest is that it is a form of individual interest because it is an enduring orientation to the topic (Schiefele, 1992, 1996). Another view is that topic interest is a form of situational interest because interest in a text topic is triggered by aspects of that topic (Hidi & McLaren, 1991). The familiarity of a topic may be an important factor in deciding whether topic interest is individual or situational (Schiefele, 2009). Interest in a familiar topic would be considered individual interest because the topic interest involved would likely have been a stable and enduring preference of the reader (Schiefele, 2009). In contrast, interest in an unfamiliar topic would be considered situational interest because the topic interest involved would likely have been elicited by appealing aspects of that topic (Hidi, 2000). Ultimately it is important to recognize that individual and situational interest are both thought to positively influence learning (Hidi, 1990).

Several researchers have tested a variety of explanations for the positive association between topic interest and learning from texts. Review of the empirical tests of these proposed explanations has not indicated a cognitive process that explains the positive association between topic interest and learning from texts. For example, it has been proposed that focused attention may explain the positive association between topic interest and learning from texts (Schiefele, 1992), but this has not been supported by empirical evidence (Schiefele & Krapp, 1996). One's level of background knowledge in a

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doi:10.1016/j.lindif.2012.07.004

topic is positively associated with one's interest in that topic because individuals typically learn more about topics in which they are interested (Garner & Gillingham, 1991; Tobias, 1994). However, findings from research studies have indicated that the positive association between topic interest and learning from texts is independent of background knowledge (Alexander, Kulikowich, & Schulze, 1994; Boscolo & Mason, 2003; Schiefele, 1990). In regard to reading strategies, Schiefele and Krapp (1996) found a positive association between topic interest and reading strategies such as note-taking and elaborating on the text; however, these reading strategies were not found to explain the positive association between topic interest and learning from text. One study yielded informative findings in which topic interest was found to increase levels of positive affect, which increased persistence, which subsequently increased learning from texts (Ainley, Hidi, & Berndorff, 2002). However, this explanation does not answer the question of what cognitive process explains the positive association between interest and learning from texts.

1.1. Inference generation

There are reasons to believe that inference generation may be a cognitive process that explains the positive association between interest and learning from texts. The reader needs to create a coherent mental representation of a text in order to learn from a text. Coherent mental representations of text are constructed through inferences (Graesser, Singer, & Trabasso, 1994; Thurlow & van den Broek, 1997). Inferences provide connections between the currently read text and the previously-read text or reader's background knowledge (Graesser, Bertus, & Magliano, 1995). Inference generation is necessary for coherence because texts are not written to explicitly state every relation between the ideas presented; a text that would do so would be cumbersome to read (Hansen, 1981; Kintsch, 1998). Readers use inferences to fill in missing information that may or may not be necessary for comprehension (Sanford & Garrod, 1982).

There is reason to expect a positive association between topic interest and inference generation. Readers vary in their inference generation depending on their *standards of coherence* which are the criteria that readers incorporate while reading to achieve their intended depth of comprehension (van den Broek, Risden, & Husebye-Hartmann, 1995). A reader with low standards of coherence would generate the minimal amount of inferences necessary to maintain basic comprehension or a "good-enough" representation of the text (Christianson, Williams, Zacks, & Ferreira, 2006; van den Broek, Bohn-Gettler, Kendeou, Carlson, & White, 2011). In contrast, a reader with high standards of coherence would generate additional inferences beyond those necessary to maintain comprehension in order to ensure thorough, in-depth comprehension of the text (van den Broek et al., 1995). Readers may or may not be aware of their standards of coherence; however, their standards of coherence will determine the cognitive processes (e.g., inference generation) while reading (van den Broek et al., 2011).

Standards of coherence are determined through a variety of factors that may involve characteristics of the context for reading, the reader or the text. A reader who has the goal of studying tends to have stricter standards of coherence and therefore engage in greater inference generation than a reader who has a goal of entertainment (van den Broek, Lorch, Linderholm, & Gustafson, 2001). A reader who is fatigued or distracted will likely have more shallow standards of coherence than one who is well-rested and attentive (van den Broek et al., 2011). The consistency of a text influences a reader's standards of coherence, but the manner of the influence may be dependent upon certain characteristics of the reader. A reader who is knowledgeable about the text's topic has more shallow standards of coherence for a consistent text whereas a reader who is not knowledgeable about the text's topic has stricter standards of coherence for a consistent text (McNamara, Kintsch, Songer, & Kintsch, 1996).

There is evidence that topic interest is a factor in a reader's standards of coherence. Some researchers have argued that topic interest prompts deep processing in which the reader thinks critically about the material presented in the text (Krapp, 1999; Schiefele & Krapp, 1996; Silvia, 2006). Inference generation is an example of deep processing because it requires that the reader go beyond the currently read sentence to make connections to previously read text information or background knowledge (Graesser et al., 1994; Lehman & Schraw, 2002). Moreover, analyses of information from post-reading self-reports have shown that readers are more likely to connect the text to background knowledge (a type of inference) when they have high levels of topic interest in the text (Schiefele & Krapp, 1996).

1.2. The present study

To determine the role of inference generation in the positive association between topic interest and learning from texts, it first must be determined if topic interest is positively associated with inference generation while reading. A think-aloud task is a useful tool for investigating whether interest is positively associated with inference generation. A think-aloud task, which involves readers reading a unit of text (e.g., a sentence), then stating what they are thinking about when reading the text, allows researchers to examine the process of reading as it unfolds (Coté & Goldman, 2004; van den Broek et al., 2001). A think-aloud task is particularly useful in examining inference generation as it is intended to capture the reading process as is happens and address how readers build their mental representations of the text (Pressley & Afflerbach, 1995). Therefore, the information gleaned from a think-aloud task may answer the question of whether topic interest and inference generation are positive associated.

If topic interest is positively associated with inference generation while reading and inference generation is positively associated with learning from text, then further analyses are necessary to determine the role of inference generation. Specifically, these analyses would determine whether inference generation explains the positive association between topic interest and learning from text as a mediator.

The purpose of this study is to determine the role of inference generation in the positive association between interest and learning from texts. Our hypothesis is that interest prompts increased inference generation that in turn prompts greater learning from texts. To test this hypothesis, two studies were conducted. The first study replicates previous findings regarding topic interest and learning from text. The second study includes a think-aloud task to measure inference generation while reading. If topic interest leads to stricter standards of coherence, this would be indicated by a positive association between topic interest and inference generation while reading. The increase in inference generation would create a more in-depth mental representation of the text thereby possibly explaining (as a mediator) why interest is positively associated with learning from the texts.

2. Study 1

The overarching purpose of this paper is to examine whether inference generation explains the positive association between topic interest and learning from text. The materials and measures used in this study have not been previously examined for associations between topic interest and learning. Therefore, it is necessary to determine if the positive relation between topic interest and learning exists for this study's experimental texts and participant population before investigating a potential cause of the positive association. For this reason, Study 1 is a pilot study for the materials and measures used in Study 2. There are two hypotheses specific to Study 1. Our first hypothesis is that topic interest will be positively associated with both measures of learning from texts (recall and answers to comprehension questions) based on previous findings reported in the literature

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(e.g., Boscolo & Mason, 2003; Naceur & Schiefele, 2005; Schiefele, 1990). Our second hypothesis is that the positive associations between topic interest and learning from text will be independent of the effects of background knowledge as measured through scores on a pre-test. It is important to address the potential effects of background knowledge given the previous findings regarding the influence of background knowledge on both topic interest and learning from texts (Boscolo & Mason, 2003; Flowerday, Schraw, & Stevens, 2004; Frick, 1992; Kintsch, 1980; Kintsch, 1998). However, our hypothesis that the positive associations between interest and learning from texts will be independent of the effects of background knowledge has been supported by previous findings (Boscolo & Mason, 2003; Schiefele & Krapp, 1996).

2.1. Method

2.1.1. Participants

Sixty-two students from a large, Upper Midwestern university participated for course credit. One participant was a non-Native English speaker and another participant refused to complete the study; therefore their data were removed. Of the remaining 60 participants, 42 were female and 18 were male, with a mean age of 20.88 years (SD = 6.84 years), 90% were Caucasian, 3.3% were African American, 1.7 were Asian American, 1.7% were multi-racial, and 3.3% declined to provide racial background information.

2.1.2. Materials

One practice and two experimental science texts were used. These texts were chosen because they provide a theoretical explanation for an observed phenomenon; therefore, learning could be assessed both in comprehension of the material presented and through application of the theory. Moreover, topic interest has been found to be positively associated with comprehension measures for science texts (Alexander et al., 1994; Ozgungor & Guthrie, 2004; Schiefele, 1990, 1991). The experimental texts were adapted from *Scientific American* articles and were 32 sentences long (see Appendix A for experimental texts).

2.1.3. Measures

2.1.3.1. Pre/post-tests. The pre-tests consisted of six open-ended questions covering material that was provided in the experimental text (see Appendix B). These pre-tests were not meant to be an exhaustive inventory, but provide an estimate of the reader's previous knowledge and familiarity with the topic. The post-test was identical to the pre-test to be able to determine that participants learned the information from the text and did not have the background knowledge prior to reading the text to correctly answer the questions. The first two questions were designed to require the participant to recall facts that were presented in the article in order to answer the question accurately. The third and fourth questions were designed to require the participant to connect information explicitly stated in the article in order to answer the question accurately. The fifth and sixth questions were designed to require the participant to apply the information presented in the article in a novel way to answer the question accurately; the information needed to answer the questions was not explicitly stated in the article. Internal consistency for the pre-test measure was questionable for the moon text, (Cronbach's $\alpha = .62$), but good for the songbirds text, Cronbach's $\alpha = .83$. The internal consistency for the post-test measure for both texts was acceptable (Cronbach's $\alpha = .80$ [moon]; Cronbach's $\alpha = .74$ [songbirds]).

Each of the questions for the pre- and post-test measures had its quality objectively assessed using the software tool QUAID (question understanding aid; Graesser et al., 2001). QUAID was developed to assist researchers in identifying questions in their measures that are difficult to understand (Graesser et al., 2001). It is important to have questions that are understandable because questions that are not understood are more likely to be answered inaccurately than questions that are understood (Graesser, Cai, Louwerse, & Daniel, 2006). The increase in inaccurate answers for questions that are difficult to understand compared to questions that are easy to understand may lead to lower reliability for test measures (Graesser, Wiemer-Hastings, Kreuz, Wiemer-Hastings, & Marquis, 2000). QUAID identifies nine categories of problems that may lead to questions that are difficult to understand: unfamiliar technical term, vague or imprecise predicate or relative term, vague or ambiguous noun phrase, complex syntax, working memory overload, misleading or incorrect presupposition, unclear question category, amalgamation of more than one question category, unclear question purpose, mismatch between question category and answer option, difficult to access specific of generic knowledge, and respondent unlikely to know answer (Graesser et al., 2006). Some of the questions in the pre- and post-test measures were identified as problematic by QUAID for containing an unfamiliar technical term (questions 4 and 5 from "Origins of the moon" and questions 1–5 from "Why American songbirds are vanishing"). The unfamiliar technical terms identified by QUAID were "isotopes" and "neotropical." These terms are used through the experimental articles and could not be removed or adapted without changing the nature of the questions. The other questions used in the pre- and post-test measures were not identified as belonging to any of the categories of problems (i.e., QUAID did not identify any problems with the questions).

2.1.3.2. Topic interest. To assess topic interest, the participants were asked to report their level of agreement with statements regarding their interest, boredom, and engagement with respect to both the specific and general text topics (see Appendix C). Interest in both the specific and general text topics was included, to allow a holistic assessment of topic interest. For example, one may have an interest in the general topic of forestry, but not have developed an interest in the specific topic of songbirds. Because forestry encompasses songbirds, interest in the general topic of forestry would likely prompt an interest in the specific topic of songbirds. Therefore, it is beneficial to include both the specific and general text topics in the topic interest measure. Interest was included to provide a simple and explicit measure of the participant's interest. Boredom, considered the opposite of interest (Caldwell, Baldwin, Walls, & Smith, 2004; Hunter & Csikszentmihalyi, 2003) was included so that the participant would be prompted to think differently about their level of interest in the topic. Engagement is considered a defining aspect of topic interest; if one is interested in a topic, then one is engaged in that topic (Frick, 1992). Internal consistency for the topic interest measure was good for the moon (Cronbach's $\alpha = .88$) and acceptable for the songbirds (Cronbach's $\alpha = .77$).

2.1.4. Procedure

After being greeted by their experimenter, participants provided informed consent and demographic information. Participants then completed pre-tests for each experimental text using pencils and paper (see Appendix B). They were instructed to answer the questions for the pre-tests only if they knew the answer (i.e., they were not to guess at the answers).

After completing the pre-tests for the experimental texts, participants completed a practice session that used the same sequence and style of measures as the experimental session. Participants completed all measures for a particular text either prior to or immediately after reading the text, then continued to the next text and its relevant measures. Participants completed a pre-reading questionnaire of their topic interest (see Appendix C). After completing the pre-reading questionnaire, participants read the text at their own pace one sentence at a time on a computer screen. After reading each text, the participants were asked to produce a written recall of the text with the instructions "Type out everything you can remember about the article you just read. Don't worry about spelling or

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grammar." Next, they completed a post-test to assess their learning (see Appendix A).

2.1.5. Data analysis

Self-report responses were used to measure topic interest. To do so, responses to items from the topic interest self-reports (items 2 and 5 were reverse-scored) were summed up to provide the measure of topic interest for each text.

The written recalls and post-test comprehension question answers were used to calculate two measures of learning from texts: the number of idea units recalled and the post-test scores. The written recalls were parsed by idea unit and coded for matching the original text's idea unit independently by four trained undergraduate research assistants. Twenty-five percent of the recalls were coded in common. Agreement on recall codes was high ($\kappa = .87$, $p < .001$). The answers to the pretests and post-tests were scored for accuracy. The answers to the comprehension questions were scored on a scale and worth two points each (2 for completely accurate answers, 1 for partially accurate answers, and 0 for incorrect answers). Twenty-five percent of the answers to comprehension questions were scored in common. Agreement on scores for each question was very high ($\kappa = .98$, $p < .001$ for pre-tests; $\kappa = .93$, $p < .001$ for post-tests). Disagreements were resolved through discussion. The sum of the points for pre-tests was a predictor variable and the sum of points for post-tests was a dependent variable in the analyses.

2.2. Results

The purpose of Study 1 was to determine whether topic interest had positive associations with the two measures of learning from texts: number of idea units accurately recalled and post-test scores on the comprehension questions. This question was first addressed by testing for Pearson correlations among topic interest, number of idea units accurately recalled, pre-test scores, and post-test scores (descriptive statistics and results are in Table 1 for the moon text and Table 2 for the songbirds text). As shown in the correlation matrices in Tables 1 and 2, there were positive associations among topic interest, number of idea units accurately recalled and post-test scores. The positive associations between the topic interest and the two learning from text variables (idea units recalled and post-test scores) converge with previous findings that higher interest is associated with increased learning from texts (Boscolo & Mason, 2003; Naceur & Schiefele, 2005; Schiefele & Krapp, 1996). Pre-test scores in Study 1 were quite low and had little variability, especially for the songbirds text, indicating that the participants had little background knowledge to answer the comprehension questions prior to reading the texts. For the songbirds text only, pre-test scores were positively associated with idea units recalled, but not with post-test scores. However the positive association between pre-test scores and idea units recalled for the songbirds text could be due to non-normality in the data, as indicated by the size of the standard deviation relative to the mean. Subsequent analysis with a nonparametric statistic (Spearman's rho), indicated no association between pre-test scores and idea units recalled for the songbirds text, $\rho(69) = .04$, $p = .79$. Therefore, the previously noted positive association between pre-test scores and idea units recalled for the songbirds texts was likely due to non-normality in the data.

The purpose of Study 1 is to replicate previous findings regarding a positive association between topic interest and learning from texts (i.e., the number of idea units recalled and post-test scores). To investigate the positive association between topic interest and learning from texts, hierarchical multiple regression analyses were performed. Hierarchical multiple regression analyses were chosen because they allow for the effects of pre-test scores to be partialed out of the effect of interest on learning. Separate hierarchical multiple regression analyses were conducted for the two measures of learning (idea units recalled and post-test scores). The dependent variables were the number of idea units recalled and post-test scores. For each analysis, pre-test scores were entered into the first step of the regression model. Topic interest was entered into the second step. As can be seen in Tables 3 and 4, topic interest was a significant, positive predictor for both idea units recalled, $t(57) = 3.21$, $p = .002$ (moon), $t(57) = 4.52$, $p < .001$ (songbirds), and the post-test scores, $t(57) = 3.46$, $p = .001$ (moon), $t(57) = 3.62$, $p = .001$(songbirds). Therefore, the purpose of Study 1 has been achieved.

2.3. Discussion

The primary purpose of Study 1 was to ascertain that previous findings regarding a positive association between topic interest and learning from texts would be found with these materials. The first hypothesis was that topic interest would be positively associated with both forms of learning from texts (the number of idea units recalled and post-test scores). The results of the study showed that topic interest was positively associated with both the number of idea units recalled and post-test scores. Therefore, the first hypothesis was supported.

The second hypothesis was that the positive associations between topic interest and learning from texts would be independent of the effects of background knowledge. This hypothesis was supported by the results from Study 1. However, the measure of background knowledge, pre-test scores, was quite low indicating that the readers in

Table 1
Descriptive statistics and correlation matrix of topic interest and learning from text variables from "Origins of the moon" in Study 1.

	Observed min	Observed max	M (SD)
Topic	13	41	26.15 (6.65)
Recall	2	32	11.78 (7.22)
Pre-test	0	7	.71 (1.34)
Post-test	0	12	6.51 (3.59)

	2	3	4
1. Topic	.40**	.21	.41**
2. Recall		.09	.69**
3. Pre-test			.12
4. Post-test			

Note. N = 60, 1. Topic = topic interest, 2. recall = number of idea units recalled, 3. pre-test = pre-test scores, and 4. post-test = post-test scores.
* $p < .05$.
** $p < .01$.

Table 2
Descriptive statistics and correlation matrix of topic interest and learning from text variables from "Why American songbirds are vanishing" in Study 1.

	Observed min	Observed max	M (SD)
Topic	6	35	19.53 (6.17)
Recall	1	29	9.47 (5.49)
Pre-test	0	6	.19 (.85)
Post-test	1	12	6.19 (3.09)

	2	3	4
1. Topic	.49**	.02	.42**
2. Recall		.43**	.55**
3. Pre-test			.12
4. Post-test			

Note. N = 60, 1. Topic = topic interest, 2. recall = number of idea units recalled, 3. pre-test = pre-test scores, and 4. post-test = post-test scores.
* $p < .05$.
** $p < .01$.

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Table 3
Hierarchical multiple regression analyses predicting learning from text variables from topic interest variable from "Origins of the moon" in Study 1.

	Recall		Post-test	
	ΔR^2	β	ΔR^2	ß
Step 1	.01		.02	
Pre-test		.08		.12
Step 2	.16**		.18**	
Pre-test		.01		.03
Topic interest		.40**		.43**

Note: N = 60. β represents standardized coefficient weights. ΔR^2 represents the change in R^2 for each step.
* $p<.05$.
** $p<.01$.

this study did not know the answers to the questions prior to reading the texts.

The results from Study 1 converge with previous empirical findings on topic interest and learning from texts. As was found in Study 1, topic interest has previously been found to be positively associated with recall (Naceur & Schiefele, 2005; Schiefele & Krapp, 1996) and accuracy in answers to open-ending reading comprehension questions (Schiefele, 1990).

The internal consistency of scores for the pre-test and post-test measures was not ideal. This is typical of open-ended comprehension questions, likely due to the relatively small number of items used (Kamalski, 2004). It may have been unwise, however, to include additional questions in an effort to obtain the level of internal consistency in other forms of comprehension assessment, such as multiple-choice questions. More effort is necessary to produce an answer to an open-ended question than to identify the answer to a multiple-choice question. Because answering open-ended comprehension questions requires more effort than answering multiple-choice questions, it is unwise to include large numbers of open-ended comprehension questions to assess learning as it may fatigue the reader. Fatigue could have hampered the increased engagement associated with topic interest, thereby making the results difficult to interpret. Moreover, it is important to note that the reliability in scoring the pre- and post-test measures was quite high. Therefore, the pre- and post-test scores can be interpreted with some confidence.

Although there are reliability issues with the use of open-ended comprehension questions, this type of item is still useful in assessing learning from text in empirical studies. Open-ended comprehension questions are frequently used in educational assessments. Therefore, findings from empirical studies using open-ended comprehension questions can be more readily applied to classroom instruction. Another advantage of open-ended comprehension questions is that participants need to provide the answers, unlike multiple-choice questions in which the answer needs to be identified. Therefore, answering the question correctly by guessing is less problematic with open-ended comprehension questions than with multiple-choice questions. Moreover, the need to actively produce an answer in an open-ended question provides a better means of assessing in-depth comprehension of a text than passively identifying an answer in a multiple-choice question (Kintsch, 2005).

In conclusion, positive association between topic interest and learning from texts was found using these materials in Study 1. In Study 2, these materials will be used to examine if inference generation explains the positive association between topic interest and learning from texts.

Table 4
Hierarchical multiple regression analyses predicting learning from text variables from topic interest variable from "Why American songbirds are disappearing" in Study 1.

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.19**		.02	
Pre-test		.43**		.12
Step 2	.22**		.19**	
Pre-test		.43**		.11
Topic interest		.47**		.44**

Note: N = 60. β represents standardized coefficient weights. ΔR^2 represents the change in R^2 for each step.
* $p<.05$.
** $p<.01$.

3. Study 2

The purpose of Study 2 to is examine whether inference generation accounts for the positive association between topic interest and learning from texts. Specifically, we hypothesize that topic interest will prompt a greater number of inferences generated. This hypothesis is based on the concept of standards of coherence that would predict that readers who are interested in the topic of the text set a higher standard for the level of coherence they want to attain and therefore generate more inferences than readers who are not interested. Such increase in number of inferences would, in turn, lead to greater learning from texts. This is because inference generation is positively associated with learning from texts (Kintsch, 1986, 1998; McNamara & Kintsch, 1996).

If inference generation is positively associated with both topic interest and learning from text, the possibility that inference generation explains this positive association will be determined through tests of mediation (cf. Baron & Kenny, 1986; Preacher & Hayes, 2008). If inference generation satisfies the tests of mediation it can be said to account for the positive association between topic interest and learning from texts. In other words, topic interest and learning from text would have less of a positive association with each other after the inclusion of inference generation because their positive association is at least partly dependent on inference generation.

It is possible that topic interest will not be positively associated with inference generation. There is no direct evidence from the literature that topic interest may be positively associated with inference generation while reading. Moreover, topic interest and inference generation may be positively associated, but inference generation may not satisfy the tests of mediation and may be statistically independent from the positive association between topic interest and learning from texts.

Inference generation is related to one's reading comprehension skill (Bowyer-Crane & Snowling, 2005; Cain & Oakhill, 2007; Cain, Oakhill, & Bryant, 2004; Cromley & Azevedo, 2007; Long, Oppy, & Seely, 1997; van den Broek et al., 2005). Therefore, reading comprehension skill is assessed through the Nelson–Denny subtest of reading comprehension in Study 2. This is to ascertain whether findings regarding a positive association between topic interest and inference generation is independent of the effects of reading comprehension skill. The findings from Study 2 can be interpreted with greater confidence if they are found to be independent of the effects of reading comprehension skill.

3.1. Method

3.1.1. Participants

Seventy students from a large, Upper Midwestern university participated for course credit. One participant did not produce think-aloud responses to more than 25% of the sentences in the experimental texts; therefore the data from this participant were removed. Of the remaining 69 participants, 39 were female and 30 were male, with a mean age of 20.97 years ($SD = 4.91$ years), 78.6% were Caucasian, 5.7% were African American, 5.7% were Asian American, 2.9% were Native American, 2.9% were multi-racial, and 4.3% declined to provide racial background information.

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3.1.2. Materials

The materials used in Study 2 were the same as those used in Study 1. The internal consistency of the pre-test scores was very low for the moon text (Cronbach's $\alpha = -.04$) and the songbirds text (Cronbach's $\alpha = .03$). Several items in both pre-tests had zero variance because no participants answered those particular questions correctly, thereby causing low internal consistency metrics. The internal consistency of the pre-test scores in Study 2 raises legitimate and serious concerns about reliability of the pre-test as a measure of background knowledge. However, one can be confident that the participants did not know the answers to the post-test questions prior to reading the texts given the very low scores for the pre-test measure.

The internal consistency of the post-test measure was questionable for the moon text (Cronbach's $\alpha = .66$) and poor for the songbirds text (Cronbach's $\alpha = .54$). As discussed in Study 1, less than desirable reliability is typical for open-ended comprehension questions (Kamalski, 2004). However, the use of open-ended comprehension questions is advantageous because they are commonly used in educational assessments.

3.1.3. Measures

The measures used in Study 2 were the same as those used in Study 1 with the addition of the Nelson–Denny.

3.1.3.1. Topic interest. The internal consistency for the topic interest measure was excellent for the moon text (Cronbach's $\alpha = .91$) and good for the songbirds text (Cronbach's $\alpha = .84$).

3.1.3.2. Reading comprehension. The Nelson–Denny Comprehension Subtest Form G consists of seven reading passages and eight multiple-choice questions each with five answer choices and a 20 minute time limit for university students (Brown, Fishco, & Hanna, 1993). The first minute of the subtest is used to obtain reading rate. Reading rate is not a variable of interest for this study; therefore, it is not used in the analyses. Scale scores were used in all analyses as a measure of reading comprehension skill. Alternate form reliability for university students between Form G and Form H is .81 (Brown et al., 1993).

3.1.4. Procedure

The procedure for Study 2 was the same as for Study 1 with the addition of the think-aloud task and the Nelson–Denny subtest of reading comprehension. For the think-aloud task, participants were instructed to read each sentence aloud at their own pace and verbally reflect or comment on what they had read (e.g. Linderholm & van den Broek, 2002; Pressley & Afflerbach, 1995; Trabasso & Suh, 1993; van den Broek et al., 2001). If a participant did not comment on the sentence, the experimenter encouraged the participant to provide a response by stating, "Please comment after every sentence." The experimenter modeled the think-aloud procedure with the beginning of the practice text; the participant read the remainder of the practice text using the think-aloud procedure before beginning the experimental texts (see Appendix D for think-aloud instructions and model responses). Think-aloud responses were recorded on a digital recorder.

The Nelson–Denny was administered at the end of the study session.

3.1.5. Data analysis

The written recalls were parsed and coded in the same manner by the same trained research assistants as in Study 1. Agreement on recall codes was very high ($\kappa = .89$, $p < .001$). The pre-test and post-test comprehension question answers were scored in the same manner as in Study 1. Agreement on scores was very high (for pre-tests $\kappa = .98$, $p < .001$; for post-tests $\kappa = .89$, $p < .001$). Disagreements were resolved through discussion.

Verbal data from the think-aloud procedure were transcribed. Each of the idea units (noun–verb combinations that express a single idea) from participant responses was coded as a text-connecting inference (explanations of or predictions for the text based on previously read information in the text), knowledge-based inference (explanations of or predictions for the text based on background knowledge), or not an inference (cf. Linderholm & van den Broek, 2002; van den Broek et al., 2001 for further explanation of coding). Inferences were further coded as valid, if they were accurate or consistent with the text, or invalid, if they were inaccurate or inconsistent with the text. Only valid inferences were included in the analyses. Two raters independently coded the think-aloud protocols. Twenty-five percent of the think-aloud protocols were coded in common. Agreement on codes for think-aloud responses was high ($\kappa = .94$, $p < .001$). Disagreements were resolved through discussion.

Text-connecting and knowledge-based inferences were combined into one variable for analyses. Potential mediators should only be examined separately if they are conceptually distinct and not highly correlated with each other (Judd & Kenny, 2010). In other words, text-connecting knowledge-based inferences should only be examined separately as potential mediators if they would provide different conceptual and statistical explanations for the positive association between topic interest and learning from text. Both text-connecting and knowledge-based inferences contribute to a coherent mental representation of the text (Graesser et al., 1994; Kintsch, 1998). In regard to conceptual explanations, text-connecting and knowledge-based inferences contribute to coherence by providing connections between the currently read text and either previously read text (for text-connecting inferences) or background knowledge (for knowledge-based inferences; Singer, 1994; van den Broek, 1990). Moreover, both text-connecting and knowledge-based inferences are affected by standards of coherence (van den Broek et al., 2011). Therefore, both types of inferences would explain the positive association between topic interest and learning from text for the same reason, that is, both types of inferences allow the reader to construct a coherent mental representation of the text. Regarding statistical explanations, the correlation between text-connecting and knowledge-based inferences was strong, $r(69) = .55$, $p < .001$, indicating a considerable amount of overlap in the two constructs.

3.2. Results

3.2.1. Comparison with Study 1

A think-aloud task was used in Study 2, whereas the participants in Study 1 read silently. One criticism of think-aloud tasks is that changes in cognitive processing may occur as a result of the participant thinking aloud while reading (cf. Whitney & Budd, 1996). These potential changes in cognitive processing may influence tasks after reading (recall and answering comprehension questions). Therefore, it is helpful to compare the after-reading results from a study with a think-aloud task to a similar study without a think-aloud task to determine if the think-aloud task affected the after-reading results.

Separate one-way ANCOVAs were conducted with the number of idea units and post-test scores as the dependent variables, pre-test scores as the covariate, and participation in Study 1 or Study 2 as the between subjects variable. The results indicated that there were indeed differences in the after-reading results from Study 1 and Study 2. Regarding the idea units recalled for the moon text, there were no significant differences for the moon text between the participants in Study 1 ($M = 11.78$; $SD = 7.22$) and the participants in Study 2 ($M = 13.63$; $SD = 6.64$), $F(1, 127) = 2.42$, $p = .12$. Similar results were found for the songbirds text, there were no significant differences between the participants in Study 1 ($M = 9.47$; $SD = 5.49$) and the participants in Study 2 ($M = 10.86$; $SD = 4.84$), $F(1, 127) = 3.17$, $p = .08$. Regarding post-test scores for the moon, there were

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no significant differences between the participants in Study 1 (M = 6.51; SD = 3.59) and the participants in Study 2 (M = 6.68; SD = 2.92), $F(1, 127) = .14$, $p = .71$. In contrast, post-test scores for the songbirds texts between studies were quite different. The participants in Study 1 (M = 6.19; SD = 3.09) answered fewer post-test questions accurately than did the participants in Study 2 (M = 8.16; SD = 2.34), $F(1, 127) = 16.18$, $p < .001$, Cohen's $d = .69$. Pre-test scores were not significant as a covariate for either recall or post-test scores for either text.

The post-test scores for the songbirds text between Study 1 and Study 2 were quite different, indicating that the think-aloud task may have influenced cognitive processing. Moreover, it is intriguing that the two texts would yield different patterns of results regarding post-test scores in studies with or without the think-aloud task. The two texts were entered separately into Coh–Metrix, a computer tool that can analyze texts for cohesion and readability (Graesser, McNamara, Louwerse, & Cai, 2004), to identify differences between the two texts. The Flesch reading ease score was lower for the songbirds text (37.19) than the moon text (47.55). Moreover, the proportion of content words that overlaps in adjacent sentences was lower in the songbirds text (.10) than the moon text (.18), indicating that it may have been easier to connect information between sentences in the moon text than the songbirds text. In addition, the final explanation for the scientific phenomenon (i.e., the disappearance of songbirds in the United States) discussed in the songbirds article was implicit; whereas, the final explanation for the scientific phenomenon (i.e., where the moon came from) in the moon article was explicit. The combination of these differences between the two texts indicates that the songbirds text was more difficult to comprehend than the moon text. Because it was more difficult, the participants in Study 2 may have benefited from reading and thinking aloud the songbirds text more so than the moon text. Thinking aloud may have prompted the reader to engage more deeply; thereby increasing the numbers of accurate answers to post-test comprehension questions for the songbirds text. Because the moon text was more coherent and easier to comprehend, readers may not have benefited from reading and thinking the moon text aloud.

3.2.2. Correlation analyses

For the moon text, the positive correlations among topic interest and learning from texts that were found in Study 1 were also found in Study 2 (see Table 5). For the songbirds text, the expected positive correlation between topic interest and the number of idea units recalled was found (see Table 6). In contrast to Study 1, there was no significant correlation between topic interest and post-test scores. Similar to Study 1, pre-test scores for both texts were quite low, suggesting a floor effect.

Regarding the variables that were only included in Study 2, the Nelson–Denny scale scores were positively correlated with the number of idea units recalled and with the post-test accuracy scores for both texts. There did not appear to be any correlations between the Nelson–Denny scale scores and topic interest. For both texts, the number of inferences was positively correlated Nelson–Denny scale scores and the two learning from text variables. For the moon text only, the number of inferences was positively correlated with topic interest.

3.2.3. Regression analysis

As with Study 1, separate hierarchical multiple regression analyses were conducted for the two measures of learning (idea units recalled and post-test scores). The dependent variables were the number of idea units recalled and post-test scores. For each analysis, pre-test scores and Nelson–Denny scale scores were entered into the first step of the regression model. Topic interest was entered into the second step. As can be seen in Tables 7 and 8, topic interest was a significant, positive predictor for the idea units recalled from both texts,

Table 5
Descriptive statistics and correlation matrix of topic interest, learning from text variables, reading comprehension skill, and inference generation from "Origins of the moon" in Study 2.

	Observed min	Observed max	M (SD)
Topic	6	42	25.51 (7.90)
Recall	1	31	13.71 (6.67)
Pre-test	0	3	.46 (.72)
Post-test	2	12	6.68 (2.92)
N–D	191	251	226.71 (13.93)
Inference	0	42	16.22 (9.66)

	2	3	4	5	6
1. Topic	.30*	.17	.45**	.04	.38**
2. Recall		.09	.52**	.25*	.26*
3. Pre-test			.23	.10	.18
4. Post-test				.49**	.63**
5. N–D					.44**
6. Inference					

Note: N = 69, 1. Topic = topic interest, 2. recall = idea units recalled, 3. pre-test = pre-test scores, 4. post-test = post-test gain scores, 5. N–D = Nelson–Denny Reading Comprehension Subtest scale scores, and 6. inference = number of inferences.
* $p < .05$.
** $p < .01$.

Table 6
Descriptive statistics and correlation matrix of topic interest, learning from text variables, reading comprehension skill, and inference generation from "Why American songbirds are vanishing" in Study 2.

	Observed min	Observed max	M (SD)
Topic	6	38	20.96 (6.55)
Recall	2	24	10.86 (4.84)
Pre-test	0	2	.16 (.44)
Post-test	4	12	8.16 (2.34)
N–D	191	251	226.71 (13.93)
Inference	2	39	16.71 (9.50)

	2	3	4	5	6
1. Topic	.30*	.19	.14	.03	.16
2. Recall		.15	.20	.23	.26*
3. Pre-test			.04	.19	.24
4. Post-test				.42**	.32**
5. N–D					.27*
6. Inference					

Note: N = 69, 1. Topic = topic interest, 2. recall = idea units recalled, 3. pre-test = pre-test scores, 4. post-test = post-test gain scores, 5. N–D = Nelson–Denny Reading Comprehension Subtest scale scores, and 6. Inference = number of inferences.
* $p < .05$.
** $p < .01$.

Table 7
Hierarchical multiple regression analyses predicting learning from text variables from topic interest variable from "Origins of the moon" in Study 2.

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.07		.27**	
Pre-test		.07		.18
N–D		.24*		.47**
Step 2	.08*		.17**	
Pre-test		.02		.12
N–D		.23*		.46**
Topic interest		.29*		.41**

Note: N = 69. β represents standardized coefficient weights. ΔR^2 represents the change in R^2 for each step.
* $p < .05$.
** $p < .01$.

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Table 8
Hierarchical multiple regression analyses predicting learning from text variables from topic interest variable from "Why American songbirds are vanishing" in Study 2.

	Recall		Post-test	
	ΔR^2	β	ΔR^2	β
Step 1	.07		.19**	
Pre-test		.11		−.08
N–D		.21		.43**
Step 2	.08*		.02	
Pre-test		.06		−.11
N–D		.21		.43**
Topic interest		.28*		.15

Note: N = 69. β represents standardized coefficient weights. ΔR^2 represents the change in R^2 for each step.
* $p<.05$.
** $p<.01$.

$t(66) = 2.47$, $p = .02$ (moon), $t(66) = 2.41$, $p = .02$ (songbirds), and the post-test scores for the moon text, $t(66) = 4.31$, $p<.001$. However, topic interest was not a significant predictor of post-test scores for the songbirds text, $t(66) = 1.3$, $p = .20$.

3.2.4. Mediation analysis

We used bootstrapping to examine the effects of the proposed mediator, inference generation, on the positive association between topic interest and learning from texts (Preacher & Hayes, 2004, 2008). In bootstrapping, samples are repeatedly taken from the data set and the effect of the independent variable on the dependent variable controlling for the proposed mediator is estimated in each resampled data set. Bootstrapping is considered an effective technique for mediation analysis because it has greater power and lower Type I error rates than other forms of mediation analysis (e.g., causal steps [Baron & Kenny, 1986]; Pituch & Stapleton, 2008; Preacher & Hayes, 2008). In order for mediation to be implicated, the 95% confidence interval for the indirect effect of independent variable (i.e., topic interest) to the dependent variable (i.e., recall or post-test scores) by way of the proposed mediator (i.e., inference generation) must not contain zero.

Separate tests of mediation were conducted for the two measures of learning from texts for each text. There was no positive association found between topic interest and inference generation for the songbirds text; therefore, tests of mediation were not conducted for either measure of learning from texts. Pretest scores and Nelson–Denny scale scores were included as covariates.

3.2.4.1. Recall. As can be seen in Fig. 1 for the moon text, the total effect of topic interest on recall, *c* path, was positive and significant, $t(64) = 2.47$, $p = .02$, as was the direct effect of topic interest on recall in which the influence of inference generation was controlled, *c′* path, $t(64) = 2.08$, $p = .04$. The *a* path connecting topic interest to inference generation was positive and significant, $t(64) = 3.43$, $p = .001$. The *b* path connecting inference generation to recall was not significant, $t(64)$ .47, $p = .64$. For inference generation to be a mediator, the 95% confidence intervals of the bootstrapped estimate of the indirect effect of topic interest on recall through the proposed mediator of inference generation cannot contain zero. The lower 95% confidence interval was −.07 and the upper confidence interval was .12. Because zero is contained in the 95% confidence intervals of the bootstrapped estimate of the indirect effect, it does not appear that inference generation is a mediator. Therefore, there is no evidence that inference generation accounts for the positive association between topic interest and recall for the moon text. With regard to the partial effects of the covariates, neither the pretest scores, $t(64) = .13$, $p = .90$, nor the Nelson–Denny scale score, $t(64) = 1.57$, $p = .12$ had a significant effect on recall.

3.2.4.2. Post-test scores. The unstandardized beta coefficient weights from the mediation test for the post-test scores from the moon text are presented in Fig. 2. For the post-test scores, the total effect of topic interest on post-test scores, *c* path, was positive and significant. The *a* path connecting topic interest to inference generation was positive and significant, $t(64) = 3.43$, $p = .001$. The *b* path connecting inference generation to post-test scores was also positive and significant, $t(64) = 3.57$, $p<.001$. The direct effect of topic interest on post-test scores, path *c*, was positive and significant, $t(64) = 4.31$, $p<.001$. In addition, the direct effect of topic interest on post-test scores in which the influence of inference generation was controlled, path *c′*, was significant, $t(64) = 2.92$, $p = .005$. For the bootstrapped estimate of the indirect effect of topic interest on post-test scores through inference generation the lower 95% confidence interval was .02 and the upper confidence interval was .10. Because zero is not contained within the 95% confidence interval of the indirect effect, it appears that inference generation is a mediator. However, the direct effect of topic interest on post-test scores was significant after the inclusion of inference generation (path *c′*). Therefore, inference generation appears to only partially account for the positive association between topic interest and post-test scores for the moon text. With regard to the partial effects of the covariates on post-test scores, pretest scores did not have an effect, $t(64) = .99$, $p = .32$, but Nelson–Denny scale scores did have an effect, $t(64) = 3.09$, $p = .003$.

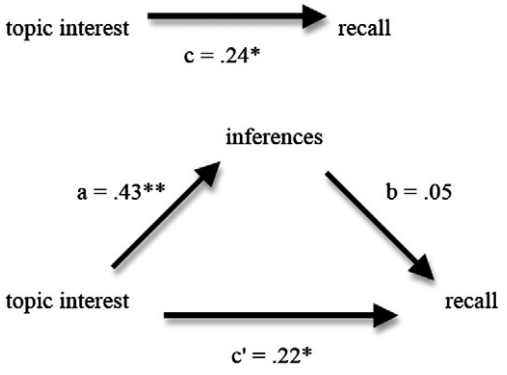

Fig. 1. Topic interest and idea units recalled for "Origins of the moon:" mediation of inference generation analysis. Note: N = 69. Path *c*: the unstandardized beta coefficient for the direct relationship between the independent and dependent variables. Path *a*: the unstandardized beta coefficient for the independent variable and mediator. Path *b*: the unstandardized beta coefficient for the mediator and dependent variable. Path *c′*: the unstandardized beta coefficient for the independent variable on the dependent variable controlling for the mediator. *$p<.05$ **$p<.01$.

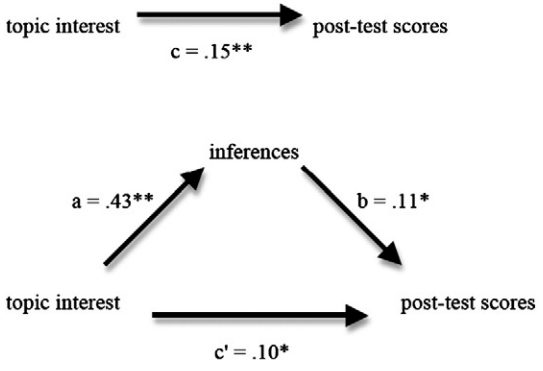

Fig. 2. Topic interest and post-test scores for "Origins of the moon:" mediation of inference generation analysis. Note: N = 69. Path *c*: the unstandardized beta coefficient for the direct relationship between the independent and dependent variables. Path *a*: the unstandardized beta coefficient for the independent variable and mediator. Path b: the unstandardized beta coefficient for the mediator and dependent variable. Path *c′*: the unstandardized beta coefficient for the independent variable on the dependent variable controlling for the mediator. *$p<.05$ **$p<.01$.

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3.3. Discussion

The purpose of Study 2 was to determine the role of inference generation in the positive association between topic interest and learning from texts. A think-aloud task was used to examine inference generation while reading two science texts, one about the origins of the moon and another on the disappearance of songbirds in America. The two texts differed in coherence level with the moon text being more-coherent and the songbirds text being less-coherent. The results indicate that there was a positive association between degree of topic interest and the amount of inference generation for the moon text only. As with Study 1, learning from texts was assessed by the number of idea units recalled and accurate answers to comprehension questions after reading (post-test scores). In Study 2, topic interest was positively associated with the number of idea units recalled for both texts. Unlike Study 1, topic interest was positively associated with post-test scores for only the moon text, which was more-coherent. Moreover, post-test scores were greater for the songbirds text in Study 2 than in Study 1. There were no other differences in the measures of learning from texts between Study 2 and Study 1.

Tests of mediation indicated that inference generation did not account for the effects of topic interest on the number of idea units recalled for the moon. However, inference generation did partially account for the effects of topic interest on post-test scores for the moon text. Tests of mediation were not conducted for the post-test scores for the songbirds text because there was no positive association between topic interest and inference generation for this text.

Inference generation has been found to be positively associated with reading comprehension skill (Cain et al., 2004; Cromley & Azevedo, 2007). For this reason, a reading comprehension measure was included in Study 2. As predicted, reading comprehension skill and inference generation were positively associated for both texts. In addition, reading comprehension skill was positively associated with post-test scores for both texts and recall for the moon text. For these reasons, reading comprehension skill was entered as a covariate in the analyses in Study 2. Therefore, the findings from Study 2 can be considered independent of reading comprehension skill.

The difference between Study 1 and Study 1 regarding the positive association between topic interest and post-test scores for the songbirds text, which was less-coherently written, may have been due to the think-aloud task in Study 2. Thinking aloud while reading has been found to increase comprehension monitoring compared to reading silently (Baumann, Seifert-Kessell, & Jones, 1992; McKeown & Gentilucci, 2007), especially for texts that are more difficult and less coherent (Loxterman, Beck, & McKeown, 1994). The songbirds text may have been more difficult for the readers as it has a lower Flesch reading ease score than the moon text. Moreover, the explanation of the scientific phenomenon examined in the songbirds text was implicit in that the readers had to infer it from the text. In contrast, the explanation of the scientific phenomenon examined in the moon text was explicit in that the readers only needed to paraphrase the text to understand it. Therefore, the songbirds texts may have been less coherent than the moon text. Thinking-aloud the songbirds text may have provided benefits for comprehension unintended in the research design. These benefits produced by thinking-aloud may have confounded any positive association that could have existed between topic interest and post-test scores for the songbirds text. Moreover, the pre-test scores, albeit near floor in both studies, were lower in Study 2 than Study 1, indicating that the participants in both studies did not know the answers to the comprehension questions prior to reading the text. Hence, it is highly unlikely that differences in background knowledge could explain the post-test scores for the songbirds text between studies.

4. General discussion

The purpose of this paper was to examine if inference generation explained the positive association between topic interest and learning from texts. To pursue this purpose, two studies were conducted. In the first study, a positive association between topic interest and learning from two science texts, as measured by recall and post-test scores, was established. In the second study, a think-aloud task was used to provide a measure of inference generation while reading. The results in Study 2 differed between the two texts of different coherence levels. The results indicate that the greater the topic interest, the greater the amount of learning from texts with the exception of answers to post-test comprehension questions for the less-coherent text in Study 2. The results indicate that the greater the topic interest, the greater the amount of inference generation while reading for more-coherent text only. In addition, inference generation appeared to increase with both measures of learning from both texts. Tests of mediation were conducted to determine if inference generation explained the positive association between topic interest and learning from texts for the less-coherent text. According to the results of the tests of mediation, inference generation does not explain the positive association between topic interest and recall. In contrast, the results of the tests of mediation indicate that topic interest does partly explain the positive association between topic interest and accurate answers to comprehension questions for the more-coherent text.

For the more-coherent text only, inference generation was positively associated with topic interest and both measures of learning from texts. However, the role of inference generation for this text differed between the two measures of learning from this text. Inference generation appeared to partly explain the positive association between topic interest and accurate answers to comprehension questions for the more-coherent text, but not the positive association between topic interest and recall. This may be because inference generation has a stronger positive association with accurate answers to comprehension questions than with recall. Recall is a more superficial measure of learning from texts than answering comprehension questions (Gilabert, Martínez, & Vidal-Abarca, 2005; Kintsch, 1994; McNamara et al., 1996). Because it is a relatively superficial measure, recall may be less dependent on inference generation than deep measures such as responses to comprehension questions.

4.1. Theoretical implications

The findings from this study indicate that inference generation may have a role, albeit a relatively small one, in the positive association between topic interest and learning from texts. As a partial mediator, inference generation appears to explain some of the positive association between topic interest and post-test scores for the more-coherent text. This is likely because topic interest may increase inference generation while reading more-coherent texts, which could in turn increase post-test scores. Hence, inference generation appears to be part of the reason that topic interest is positively associated with learning from more-coherent texts as measured by responses to comprehension questions. However, inference generation did not appear to have a role in the positive association between topic interest and recall for either text or between topic interest and post-test scores for the less-coherent text. Therefore the theoretical implications of this study in regard to understanding the relationship between topic interest and learning from texts are limited.

If future studies find more robust and decisive findings linking topic interest and inference generation, it may be determined that topic interest is a factor in a reader's standards of coherence. The findings from this study indicate that readers may generate more inferences when they were interested than when they were not interested, albeit only for texts that are coherently-written. Standards of coherence may determine the number of inferences a reader generates to construct a

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mental representation of the text (van den Broek et al., 2011). However, there were no direct measures of standards of coherence incorporated into this study; therefore, it cannot be definitely determined that topic interest influenced readers' standards of coherence.

It has been previously suggested that topic interest prompts a deeper understanding of the text while reading (Krapp, 1999; Schiefele & Krapp, 1996; Silvia, 2006). The results from this study support this notion, although only for coherently-written texts. The idea that topic interest prompts deeper processing has been previously based on the products of reading such as answers to difficult questions that require an in-depth analysis of the text or solving problems presented in the text (Boscolo & Mason, 2003; Schiefele, 1990; Silvia, 2006). The findings indicated that topic interest and a process of reading, inference generation, may be positively associated, although only for certain types of texts. Inference generation is considered indicative of deep processing because it requires the reader to think critically by connecting what is being read with background knowledge or previously read information in the text (Best, Rowe, Ozuru, & McNamara, 2005).

4.2. Pedagogical implications

Reading instructors are not always able to choose interesting texts for their students to read or allow students to read only topics in which they are interested. However, the findings in this study, if replicated in future studies, may have implications for instruction when the material is not interesting for the students. The findings presented in this study indicate that inference generation is positively associated with topic interest, albeit only for coherently-written texts. Moreover, a previous study has found interest and self-reported understanding ratings of science texts were positively associated prior to training which prompted inference generation, among other reading strategies (Taylor, Sinclair, & McNamara, 2006). After this reading-strategy training there was no longer a positive association between interest and self-reported understanding ratings of science texts (Taylor et al., 2006). Therefore, future studies may find that interventions designed to encourage inference generation, such as SERT and iSTART (McNamara, 2004; McNamara, O'Reilly, Rowe, Boonthum, & Levinstein, 2007) or questioning-while-reading interventions (Rapp, van den Broek, McMaster, Kendeou, & Espin, 2007; Trabasso, van den Broek, & Liu, 1988), may be especially effective when students are not interested in the text, provided the texts are written coherently.

4.3. Future research

This study raises the interesting question of what explains the positive association between topic interest and recall. The findings from this study clearly indicate that inference generation does not explain the positive association between topic interest and recall. One potential cause could be related to an increase in attention when interested. Attention, as measured by post-reading self-reports, has not been found to explain the positive association between topic interest and learning from texts (Schiefele & Krapp, 1996). There have not been previous studies on topic interest and attention, as measured by reading times and secondary-task reaction times. There have been previous studies on secondary-task reaction times while reading and interest, albeit not topic interest, but the findings have been mixed (Anderson, 1982; McDaniel, Waddill, Finstad, & Bourg, 2000; Shirey, 1992; Shirey & Reynolds, 1988). Future work with a focus on topic interest and attention as measured by secondary-task reaction times could serve to disentangle the conflicting results in previous studies and clarify the role attention has in the positive association between topic interest and recall of texts.

5. Conclusion

The findings from this study indicate that inference generation is positively associated with topic interest in coherently-written texts. Moreover, inference generation may explain part of the positive association between topic interest and accurate answers to comprehension questions. Although the findings were limited to coherently-written texts, they contribute to our understanding of how topic interest as it relates to text comprehension. Specifically, these findings support the previously-discussed idea that topic interest increases the depth at which a text is processed. Studies exploring how topic interest relates to the process of text comprehension help develop our understanding of interest and learning.

Acknowledgments

This research was supported by an Institute of Education Sciences Training Program Grant (R305C050059). We thank Dr. Mark Davison for his helpful comments regarding data analyses. We also thank research assistants for collecting, transcribing, and coding data.

Appendix A

Experimental texts

Origins of the moon

The Apollo spaceflights of the 1970s greatly advanced our understanding of both the moon and the earth, including the question of how our moon originated.

Information gained from the Apollo program allowed us to reject several old theories and pointed toward an important new theory about the origins of the moon.

One of several theories of the moon's origin developed over the past 200 years is the “capture hypothesis.”

The theory holds that the earth's gravitational field seized a fully formed moon that came whizzing in from elsewhere in the solar system.

In fact, the chances of the paths of two objects being just right for such a capture are miniscule, so the theory was not widely endorsed even before Apollo.

Moreover, the capture hypothesis would have required earth to have had a large atmosphere in order to have slowed the movement of the moon; most scientists concur that there is not sufficient evidence that such an atmosphere existed during this time.

Testing of the chemical composition of lunar rocks brought back by the Apollo spaceflights put the capture hypothesis theory completely to rest.

It was shown that the moon rocks had quantities of oxygen isotopes similar to rocks on earth indicating that the moon and the earth were approximately the same age and were formed about the same distance from the sun.

The second classic theory of the moon's origins, the “fission hypothesis,” was proposed by George Darwin (the second son of Charles Darwin) in the late 1870s.

He hypothesized that the earth was spinning extremely fast during a period after it formed a core when it was relatively young.

The spinning caused it to bulge so much at the equator that a small blob of the earth's crust eventually spun off by centrifugal force, becoming the moon.

This hypothesis can account for the fact that the moon is much less dense than the earth and for the similar quantities of oxygen isotopes between the earth and the moon.

However, the fission hypothesis claims that the moon was formed from material near the earth's surface, specifically where the Pacific Ocean is located.

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Researchers have since determined that the basin which contains the Pacific Ocean was formed 70 Ma ago and the moon is 4.5 billion years old.

Moreover, the moon should have exactly the same chemical composition as the corresponding material on earth for the fission hypothesis to be accurate.

Thus, the fission hypothesis cannot explain Apollo's finding that the earth and the moon have different chemical compositions outside of their similarities with quantities of oxygen isotopes.

The third classic theory is the "double planet hypothesis" also called the "co-accretion hypothesis", which states that the moon and the earth formed from the same cloud of gas and dust.

The dust and gas gradually coalesced into the earth and a ring of material formed in orbit around the growing planet; the raw materials for the moon came from the ring.

The double planet hypothesis can account for the similar composition of the earth and the moon with respect to oxygen isotopes and explain why the earth and the moon are approximately of the same age.

However, the theory claims that the two bodies were formed from the same materials in the same fashion which does not explain why the densities of the two bodies are so different.

In addition, the theory cannot explain why the moon's metallic core is so much smaller than that of the earth (earth's metallic core is approximately 50% of its radius; whereas, the moon's metallic core is 25% of its radius).

The theory also does not explain the issue of angular momentum; that is; why the earth rotates as fast as it does or how the supposed ring could have acquired enough circular motion to stay in orbit while the moon formed.

The data discrediting classic theories of the moon's origins prompted astronomers to resurrect and further develop a fourth theory, the "giant impact hypothesis."

This hypothesis states that a very large object, roughly the size of the planet Mars, collided with the earth.

The "impactor" caused debris to be thrown into orbit, which provided the raw material for the formation of the moon.

This theory explains why the moon has proportionally less metallic iron at its core than the earth because the core of the object that collided with the earth stuck to the earth thereby increasing the earth's metallic core.

The similar isotopic composition of the earth and the moon is because the earth and the impactor formed in the same region of the evolving solar system.

The earth and the impactor were not formed of identical material, so they would be expected to have different chemical compositions.

The different chemical compositions of the earth and the moon exist because the material from which the moon was formed came mostly from the impactor.

Most importantly, the impact hypothesis can explain the most difficult theoretical problem of why the earth rotates as fast as it does.

A colliding body would probably not have struck the earth squarely; rather, it is highly likely that it would have struck the earth off-center at an oblique angle.

Such a blow would have acted like a basketball player's hand glancing off the side of the basketball to keep it spinning on his finger; thereby, speeding up a slowly rotating earth to its current frequency of rotation.

Why American songbirds are vanishing

The steep declines in waterfowl, shoreline birds, and grassland birds over the past several decades are generally well understood.

What is not as obvious is why forest-dwelling migratory songbirds are also vanishing; especially the so-called neotropical migrants that breed in northern latitudes but migrate to winter homes in the tropics.

The reason for diminishing songbird population is important to understand given the necessity of songbirds in forested ecosystems by pollinating flowers, dispersing sees, and controlling insect populations.

As reports of decreases in songbird populations accumulated, it was widely noted that the missing species could still be found in large continuous tracts of forests, but not in isolated tracts.

This observation was dubbed the "forest fragmentation effect."

One simple hypothesis to explain the forest fragmentation effect is that they generally prefer larger forest plots as nesting sites and so avoid isolated plots because they tend to be small.

This hypothesis predicts that the density of "songbird's" nests in a forest will increase as the size of the forest increases.

However, when researchers set about documenting the presence or absence of songbird species in forest fragments of different sizes, they obtained mixed and – sometimes – contradictory results.

Another hypothesis is that many songbirds are averse to the edges of forests and reject small, isolated tracts because none of the habitats is far away enough from the edges.

There are good reasons why songbirds might want to nest away from the edge of a forest.

Forest margins are brighter, warmer, drier and windier than the interior and support more shrubs, vines and weeds.

This hypothesis was tested by observing the distribution of nesting territories in large forests that either surrounded a reservoir or had swaths cut to accommodate power lines.

The results of the test proved that the hypothesis was wrong.

A third hypothesis derives from the observation that the species whose numbers have declined most drastically are the long-distance, neotropical migrants.

This hypothesis holds that tropical deforestation in South America (the winter home of the neotropical migrants) is responsible for the declines, rather than fragmentation of the breeding habitat.

The hypothesis predicts that declines should be greatest for species that winter in regions undergoing rapid deforestation and least for species that winter in relatively unscathed parts of the tropics.

Comparisons of different species of neotropical migrants do not support the hypothesis.

Two specific environmental changes have been identified that appear responsible for at least some of the decline in the songbird population.

First, the suburbs are havens for nest predators such as blue jays, raccoons and opossums, so the dwindling numbers of them in isolated woodlots might be directly due to the activity of these animals.

Because one-fifth of songbird species are ground-nesters, they are particularly vulnerable to raccoons and opossums.

To test this hypothesis, one scientist placed quail eggs in artificial nests and set them out in small, medium and large forests, and – for an undisturbed control site – in the Great Smoky Mountains National Park.

The results of the experiment confirmed the hypothesis: eggs in isolated woodlots were more likely to be taken by predators than the control.

The second factor responsible for the declining songbird population is an increase in nest parasites.

Parasitic birds lay their eggs in the nests of other species, which often raise the resulting offspring as their own.

A parasite's eggs typically hatch sooner than the eggs of its host, giving the hatchling parasite a head start over its nest mates.

By the time the host's eggs hatch, the parasite is so much bigger than the host's hatchlings that it obtains most of the food brought by the parents and the host's own offspring often starve.

A study in Wisconsin showed that 65% of the nests located near forest edges were parasitized by the cowbird.

The accessibility of isolated forest tracts to nest predators and parasites explains why the songbird populations are declining in these areas.

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We must also account for the fact that the neotropical migratory songbirds have declined so much more quickly than other songbirds.

In fact, it is not necessary to hypothesize a mechanism that selects the neotropical birds out for special treatment because these migrants are naturally at a disadvantage in their breeding efforts.

The neotropicals have a shorter breeding season and lay fewer eggs than other species.

Therefore, any environmental changes that reduce nesting success indiscriminately across all species would hit neotropical migrants hardest because they have less margin for tolerance.

Appendix B

Comprehension questions for experimental texts

Directions: Type the answer after each question or statement. If you do not know the answer, do not guess; leave the answer blank and continue on to the next question. Don't worry about spelling or grammar!

"Origins of the moon"

1. Name one similarity in the physical/chemical composition of the earth and the moon. Name one dissimilarity in the physical/chemical composition of the earth and the moon.
2. Why was the capture hypothesis of the moon's origins unpopular even before the Apollo spaceflights? What evidence did the Apollo spaceflights provide that completely discredited the capture hypothesis?
3. Describe the double planet hypothesis of the origin of the moon. State one scientific fact or research finding supporting that particular theory.
4. George Darwin developed which theory of the origins of the moon? State one scientific fact or research finding discovered since he developed this theory that discredits the theory.
5. One common criticism of the giant impact theory is that it does not adequately explain the issue of quantities of oxygen isotopes in rocks on the moon and the earth. Do you agree or disagree with this criticism? Give a reason or research finding to support your opinion.
6. Suppose, Phobos, a moon of Mars, has different chemical composition than Mars. If there were evidence it was created in a different time and space than Mars, which theory of the origin of the earth's moon could best explain the origin of Phobos? Give one research finding to support your answer.

"Why American songbirds are vanishing"

1. What are the breeding and migration patterns of neotropical songbirds?
2. What is the forest fragmentation effect hypothesis? Has research evidence on nesting behavior supported the forest fragmentation effect hypothesis or not?
3. How do nest parasites affect neotropical songbird populations? Include one research finding in your answer.
4. Research findings have indicated that neotropical songbirds are more affected by changes in their environment in North America than in South America. Why would that be the case? Include two facts or research findings in your answer.
5. Name two issues or problems that neotropical songbirds have in suburbs.
6. What could be an effective method to increase songbird population? Give an example of evidence from research that supports your answer.

Appendix C

Topic interest inventories

Directions: Everyone has particular feelings and attitudes about reading certain topics and texts. Here are a number of statements regarding reading about the topics of the text you will read. Please choose a number for each statement to indicate the extent to which you agree or disagree with that statement. Write the number you chose after the statement.

1	2	3	4	5	6	7
Disagree strongly	Somewhat disagree	Disagree a little	Neither agree nor disagree	Agree a little	Somewhat agree	Agree Strongly

Topic interest items for "Origins of the moon"

1. I am interested in reading about the moon.
2. Reading about the moon is boring for me.
3. I am engaged when reading about the moon.
4. I am interested in reading about astronomy.
5. Reading about astronomy is boring for me.
6. I am engaged when reading about astronomy.

Topic interest items for "Why American songbirds are vanishing"

1. I am interested in reading about songbirds.
2. Reading about songbirds is boring for me.
3. I am engaged when reading about songbirds.
4. I am interested in reading about forestry.
5. Reading about forestry is boring for me.
6. I am engaged when reading about songbirds.

Appendix D

Instructions given to participants for think-aloud task

In this study, you'll be asked to read one practice and two experimental texts. Unlike other times when you read, you will be asked to "think aloud" as you read each passage and make comments on what you have just read. For example, you may want to make predictions about what you are reading, rephrase what you think the text is saying, share an analogy that describes something in the text that you're familiar with, remark on something in the text that is confusing, explain why something is happening, or say anything else that helps you understand the text you're reading better. At the end of the experimental articles, you will write recalls and take posttests.

The articles will be shown one sentence at a time on the computer screen. So what you do is you read aloud the sentence shown on the computer screen. Then you "think aloud" what that particular part of the article makes you think of. When you're finished, you will press the space bar and go on to the next sentence. Once you have moved past a sentence, you cannot look back at it.

Development of a therapy for meningitis

This is the title of the article. The article will probably explain ideas about how meningitis is treated.

Few frustrations in medicine can match that of a doctor who holds a potent drug within inches of an infection it cannot reach.

That makes sense that doctors would be frustrated if they couldn't treat an infection. Given the title, meningitis must be an infection that is difficult to treat.

This frustration is rare for doctors treating an infection of the body, but all too common for neurologists treating an infection of the brain.

So infections in the brain must be more difficult to treat than infections in the rest of the body.

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The reason is the blood–brain barrier.

I don't know what the blood–brain barrier is.

The walls of blood vessels in the body are composed of loosely overlapping cells that allow many substances to flow into and out of them.

Ok, blood vessels in the body are constructed so substances can flow through them. I think this article will explain how blood vessels in the brain are constructed differently.

In contrast, the walls of blood vessels in the brain are more tightly lined, allowing a few nutrients to permeate them while fending off most other substances.

Ok, so the blood vessels in the brain are different than the blood vessels in the body. The blood–brain barrier must exist because the walls of the blood vessels in the brain are more tightly lined.

This characteristic greatly reduces the chances of infection of brain tissues, but it also greatly increases the difficulty of treatment when an infection does occur.

Well, that makes sense. If there is a barrier, substances, like infections, wouldn't travel easily into the brain.

That is why bacterial meningitis is one of the biggest killers of adults and children worldwide. Until very recently, it killed up to one third of its victims.

Wow, that's a very high fatality rate. It must be because it's so difficult to train brain infections and bacterial meningitis is a brain infection.

Of the survivors, more than half suffered brain damage leading to deafness or paralysis.

That's horrible! I wonder how it can be treated.

Now you can try it with the rest of the passage while reading aloud, and we can work together in case you have any questions.

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Please cite this article as: Clinton, V., & van den Broek, P., Interest, inferences, and learning from texts, *Learning and Individual Differences* (2012), doi:10.1016/j.lindif.2012.07.004

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Please cite this article as: Clinton, V., & van den Broek, P., Interest, inferences, and learning from texts, *Learning and Individual Differences* (2012), doi:10.1016/j.lindif.2012.07.004